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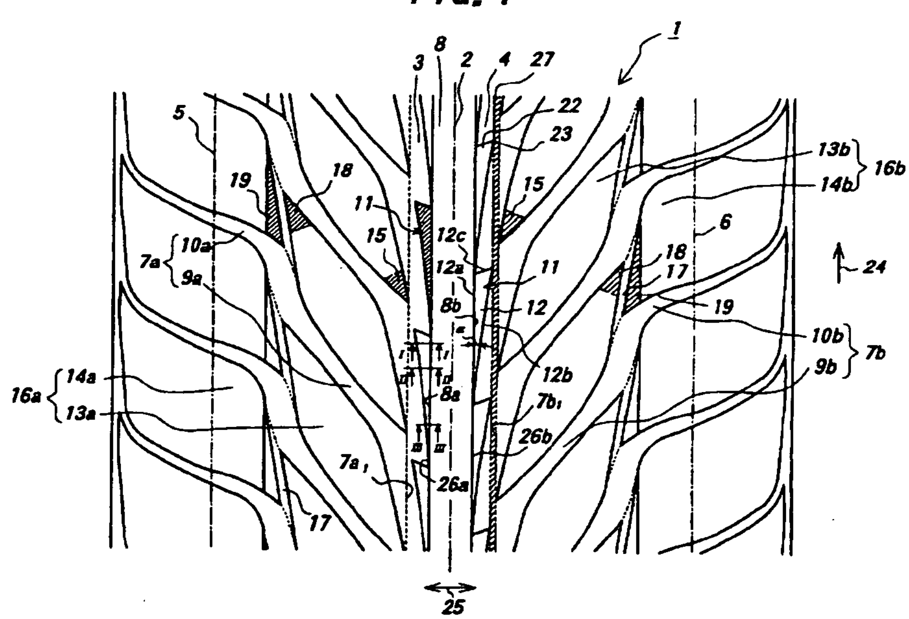
(54) **PNEUMATIC TIRE**

(57) There is provided a pneumatic tire, particularly a high-performance tire capable of effectively enhancing a drainage property without sacrificing the other tire properties, wherein a pseudo-land portion (11) promoting a smooth inflow of water flowing in circumferential grooves (3), (4) into slant grooves (7a), (7b) is formed in the circumferential groove (3), (4).

FIG. 1



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groove wall; (5) to have such a part closest to the slant groove opening to the circumferential groove that a height measured from a groove bottom of the circumferential groove is within a range of 10-60% of a maximum depth of the circumferential groove; and/or (6) to have such a slant surface that a height is gradually decreased toward the side of the slant groove opening to the circumferential groove.

[0013] And also, the slant surface of the pseudo-land portion is preferable (I) to be substantially a flat shape or substantially a curved shape. In addition, when the slant surface is substantially the curved shape, it is preferable that (II) a center of curvature is located outward from the slant surface in a radial direction of the tire or inward from the slant surface in the radial direction of the tire. Furthermore, it is preferable that (III) when the slant surface of the pseudo-land portion is projected onto a ground contact face of the tire, its shape is approximately triangular or trapezoidal; (IV) an oblique side opposite to a basic side successively enters in the ground contact face from a side near to a side wall of a rib-shaped land portion toward a side apart therefrom; (V) when the basic side and the oblique side are projected onto the ground contact face of the tire, the slant surface is isosceles triangular wherein their length are substantially equal to each other and an angle (α) therebetween is within a range of not more than 20°; (VI) a position of an intersecting point between the basic side and the oblique side is arranged at a lowest side of the slant surface viewing the tire from a front face; (VII) a shape of the oblique side projected onto the ground contact face of the tire is a curved line in which a center of curvature is located outward in a widthwise direction of the tire; and/or (VIII) the basic side of the slant surface is substantially the same height position as a maximum height position of the first groove wall or is located inward from the maximum height position of the first groove wall in the radial direction of the tire.

[0014] Furthermore, it is preferable that a pair of circumferential grooves are arranged in the tread portion to form a rib-shaped land portion between these circumferential grooves. The rib-shaped land portion is preferable (i) to be continuously arranged in the circumferential direction of the tire; (ii) to have a center position in the widthwise direction substantially coincident with a pattern center position; and/or (iii) to have a cross angle (θ) between the slant surface and a ground contact face of the rib-shaped land portion or a phantom plane arranged in parallel to such a ground contact face within a range of 120-150° viewing at a section in the widthwise direction of the tire.

[0015] Moreover, it is preferable that a corner part of a land portion defined by the arrangements of the circumferential groove, slant grooves and/or tread end at the side of the equatorial plane of the tire is formed at an acute angle and arranged at a position entering in the ground contact region on the heels of the pseudo-land portion. And also, the corner part is preferable (a) be arranged on the same circumference of the tire as an intersecting point between a section of the pseudo-land portion having a maximum sectional area and the oblique side of the slant surface or on an extension line of the oblique side; (b) to be subjected to a chamfering, more preferably, a chamfering forming a smoothly curved shape; and/or (c) to be connected with the pseudo-land portion.

[0016] Furthermore, the slant groove opening to the circumferential groove is preferable to be arranged so as to separate away from the circumferential groove toward a given circumferential direction of the tire. In addition, it is preferable that all of the slant grooves each opening to each of the pair of circumferential grooves and extending toward the respective ground contact end of the tread are arranged in a direction of successively entering in the ground contact face from the side of the circumferential groove toward the side of the ground contact end to thereby form a directional pattern in the tread portion.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

Fig. 1 is a diagrammatically partial developed view of a tread pattern in a pneumatic tire (Example 1) according to the invention.

Figs. 2a to 2c are section views taken along lines I-I, II-II and III-III of a pseudo-land portion shown in Fig. 1, respectively.

Figs. 3a to 3c are section views similar to those of Fig. 2 in another pseudo-land portion having a shape different from that of Fig. 2, respectively.

Figs. 4a to 4c are section views similar to those of Fig. 2 in the other pseudo-land portion having a shape different from that of Fig. 2, respectively.

Figs. 5a to 5c are section views similar to those of Fig. 2 in the other pseudo-land portion having a shape different from that of Fig. 2, respectively.

Figs. 6a and 6b are schematically plan views of a slant surface of a pseudo-land portion 11 having a shape different from that of Fig. 1, respectively.

Fig. 7 is a diagrammatically partial developed view of a tread pattern in a tire of Example 2.

Fig. 8 is a diagrammatically partial developed view of a tread pattern in a tire of Example 3.

Figs. 9a to 9c are section views taken along lines I-I, II-II and III-III of a pseudo-land portion shown in Fig. 8, respectively.

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to the slant groove 7a, 7b opening to the circumferential groove 3, 4 comes close to the opening portion $7a_1$, $7b_1$ of the slant groove 7a, 7b to the circumferential groove 3, 4, water flowing in the circumferential groove 3, 4 just after the contact of the portion of the tire with the ground can be smoothly flowed into the slant groove 7a, 7b of different arranged angles.

[0031] Furthermore, when the pseudo-land portion 11 is arranged adjacent to a first groove wall 26a, 26b of the circumferential groove 3, 4 forming the pseudo-land portion located at a side not opened with the slant groove 7a, 7b, it is possible to ensure a straight-shaped groove portion 27 in the circumferential groove 3, 4 as shown by oblique lines in Fig. 1, whereby the drainage efficiency in the circumferential groove 3, 4 is enhanced.

[0032] In addition, by the decrease of the groove volume in the circumferential groove 3, 4 accompanied with the arrangement of the pseudo-land portion 11 in the circumferential groove 3, 4 can be restricted the excessive drainage amount in the forward direction of the tire to prevent the increase of water amount ahead in the forward direction, which advantageously acts to control the occurrence of hydroplaning phenomenon.

[0033] Moreover, in order to improve the steering stability on a dry road surface by reinforcing a rigidity of a rib-shaped land portion 8 as mentioned later, Fig. 1 shows a case that the pseudo-land portion 11 is jaggedly arranged on the side wall of the rib-shaped land portion 8 in accordance with an arranging interval of the opening position $7a_1$, $7b_1$ in the slant groove 7a, 7b and is fixed to the first groove wall 26a, 26b. If it is required to control shoulder wear, sipe or the like is arranged between the pseudo-land portion 11 and the first groove wall 26a, 26b to separate them from each other, whereby the rigidity in the center land portion may relatively be lowered.

[0034] And also, a part (position 23 in Fig. 1) of the pseudo-land portion 11 closest to the slant groove 7a, 7b opening to the circumferential groove 3, 4 forming the pseudo-land portion is preferable to have a height measured from a groove bottom 20 of the circumferential groove 3, 4 within a range of 10-60% of a maximum depth of the circumferential groove 3, 4. When the height is less than 10%, water almost flows toward the circumferential direction and the effect of flowing water into the slant groove 7a, 7b tends to become small, while when the height exceeds 60%, the flow in the circumferential direction is restricted and the drainage property in the forward direction becomes unstable and there is a fear of lowering a speed of limiting the occurrence of the hydroplaning phenomenon. By adopting such a construction, the flow ahead the circumferential direction before the contact of the tire with the ground and the flow to the slant groove 7a, 7b after the contact of the tire with the ground can simultaneously be established at a higher level.

[0035] Furthermore, when the pseudo-land portion 11 is rendered into a shape of protruding in the circumferential groove 3, 4 from the side of the first groove wall 26a, 26b as mentioned above, water flowing in the circumferential groove 3, 4 is forced to change into the flow of water into the slant groove 7a, 7b through the pseudo-land portion 11.

[0036] For this end, when it is required to more promote the smooth inflow of water flowing in the circumferential groove 3, 4 into the slant groove 7a, 7b, the surface of the pseudo-land portion 11 is preferable to be rendered into a slant surface 12 having a height gradually decreased toward the side of the slant groove 7a, 7b opening to the circumferential groove 3, 4 forming the pseudo-land portion.

[0037] The slant surface 12 of the pseudo-land portion 11 comprises a basic side 12a arranged opposite to and adjacent to the first groove wall 26a, 26b and an oblique side 12b opposite to the basic side 12a as shown in Figs. 2a-2c and the like, but also may be formed so that it is continuously connected to the groove bottom 20 of the circumferential groove (for example, arc-shaped) to make a boundary line there-between or the above oblique side unapparent as shown in Figs. 4a-4c and 5a-5c.

[0038] Moreover, the term "oblique side" used herein includes not only a case that the oblique side 12b inclines with respect to the basic side 12a in a plan view when the slant surface 12 is projected onto the ground contact face of the tire as shown in Figs. 1 and 6b, but also a case that the oblique side 12b is in parallel to the basic side 12a in the above plan view but inclines with respect to the basic side 12a in a side view when the slant surface 12 is projected onto the equatorial plane 2 of the tire as shown in Fig. 6a, that is, a case that the oblique side 12b and the basic side 12a have a relation of skew position.

[0039] And also, the drainage can easily be conducted by locating the basic side 12a of the slant surface 12 at the ground contact face side of the tread portion 1 and locating oblique side 12b thereof at the side of the groove bottom 20 in the circumferential groove 3, 4. As the contact of the portion of the tire with the ground proceeds, water flowing in the circumferential groove 3, 4 easily changes through the slant surface 12 of the pseudo-land portion 11 and can be more smoothly flowed into the slant groove 7a, 7b.

[0040] As a result, the tread pattern can be made suitable for the drainage mechanism corresponding to the change of the flow phenomenon in the tread grooves 3, 4 and 7a, 7b with the lapse of time, whereby the efficient drainage can be conducted.

[0041] And also, it is favorable that the slant surface 12 is rendered into substantially a flat shape (Figs. 2-5) or into substantially a curved shape from a viewpoint of performing the smooth drainage without disorder.

[0042] Moreover, when the slant surface 12 is rendered into substantially the curved shape, if the drainage property is thought to be important, the slant surface 12 is preferable to be formed such that a center of curvature thereof is located outward from the slant surface 12 in the radial direction of the tire, while if the ground contacting property and

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cumferential groove 3, 4, the slant groove 7a, 7b and/or the tread end and located at the side of the tire equator 2 is formed at an acute angle, and the corner part 15 is arranged at a position entering into the ground contact region after the pseudo-land portion 11 in order to make the inflow of water from the circumferential groove 3, 4 to the slant groove 7a, 7b more smooth. And also, it is preferable that the corner part 15 is arranged on the same circumference of the tire as an intersecting position between a cross section S of the pseudo-land portion 11 having a maximum cross sectional area and the oblique side 12b of the slant surface 12, or on an extension line of the oblique side 12b (Fig. 7) from the same reason as mentioned above. In addition, it is preferable that the corner part 15 is subjected to a chamfering, more preferably a chamfering for the formation of a smoothly curved shape in view of ensuring the keeping of the drainage volume in the forward direction of the tire and the rigidity of the block.

[0056] And also, when the corner part 15 is connected with the pseudo-land portion 11, the branch flowing of water flowing in the circumferential groove 3, 4 into the slant groove 7a, 7b can be conducted more positively and smoothly.

[0057] Moreover, as means for connecting between the pseudo-land portion 11 and the corner part 15, mention may be made of a case that the corner part 15 is directly connected to the pseudo-land portion 11 (Fig. 8) and a case that an inflow promoting wall is arranged between the corner part 15 and the pseudo-land portion 11.

[0058] The slant groove 7a, 7b is sufficient to be such a shape that it obliquely extends between the circumferential groove 3, 4 and the ground contact end 5, 6 of the tread with respect to the circumferential direction of the tire. For example, in order to improve the drainage property, it is preferable that as shown in Fig. 1, the slant groove 7a, 7b is arranged so as to make an angle of a groove portion 9a, 9b located in a central region of the tread with respect to the circumferential direction of the tire small and an angle of a groove portion 10a, 10b located at a side region of the tread large. However, both groove portions 9a and 10a, 9b and 10b may be arranged at the same angle. Moreover, it is preferable that the angle of the slant groove 7a, 7b is within a range of 5-50° in the groove portion 9a, 9b located in the central region of the tread and within a range of 60-85° in the groove portion 10a, 10b located in the side region of the tread.

[0059] In addition, the pair of the slant grooves 7a and 7b located on both sides of the tread center may be formed in an axial symmetry with respect to the tread center or may be formed so as to offset each other in the circumferential direction of the tire as shown in Fig. 1.

[0060] When the slant grooves 7a, 7b opening to the circumferential grooves 3, 4 are arranged so as to separate away from the circumferential grooves 3, 4 toward a given circumferential direction 24 of the tire, the drainage property toward the sideward direction of the tire just after the contact of the tire with the ground inclusive of the contacting with the ground can effectively be increased.

[0061] Moreover, in order to obtain a higher drainage property, it is more preferable that the slant grooves 7a, 7b each extending from the circumferential groove 3, 4 toward the ground contact end 5, 6 of the tread are arranged in such a direction that they successively enter into the ground contact face from the side of the circumferential groove 3, 4 toward the side of the ground contact end 5, 6 of the tread to thereby form a directional pattern in the tread portion 1.

[0062] Although the above is described with respect to only an embodiment of the invention, various modifications may be taken within a scope of the invention.

[0063] For example, as shown in Fig. 1, an additional groove 17 may be arranged to further divide the slant land portions 16a, 16b located between the slant grooves 7a-7a and 7b-7b into two block land portions 13a and 14a, 13b and 14b.

[0064] In this case, the same chamfering as mentioned above may be applied to a corner part 18 of the block land portion 13a, 13b located at the ground contact end side of the tread.

[0065] Further, it is possible that a slant surface similar to the slant surface 12 of the pseudo-land portion 11 is formed in a side edge part 19 of a block land portion 14a, 14b adjacent to the corner part 18.

[0066] Furthermore, Fig. 8 shows a developed view of another tread pattern according to the invention. As shown in this figure, each of slant land portions 16a, 16b defined by slant grooves 7a and 7a, 7b and 7b formed at given intervals on the same circumference may be extended so as to gradually widen from an acute corner part 15 adjacent to the circumferential groove 3, 4 toward the side of the tread end and also a wide-width part of the slant land portion 16a, 16b can be bifurcated by a lateral sub-groove 29 extending substantially in parallel to the slant groove 7a, 7b across the ground contact end 5, 6 of the tread.

[0067] Moreover, Figs. 9a-9c show cross sections taken along lines I-I, II-II and III-III of Fig. 8, respectively.

[0068] In the tread pattern of Fig. 8, as shown in Fig. 9c, the groove bottom of the circumferential groove 3, 4 is pushed out up to a half of a maximum depth thereof at an end position of the wide-width side in the pseudo-land portion 11. Such a pushed groove bottom can contribute to the smooth inflow of water flowing in the circumferential groove 3, 4 into the slant groove 7a, 7b and prevent the violent change of the groove volume at the end position of the pseudo-land portion 11 to control the disorder of the water flow. And also, the pushing amount of the groove bottom in the circumferential groove 3, 4 in Fig. 1 is constructed so as to gradually degrease along the rib-shaped land portion 8 and become zero in a zone ranging from the line III-III of Fig. 8 to the adjoining pseudo-land portion 11, but such a construction may properly be modified, if necessary.

[0069] In addition, a sipe 30 extending straightforward and opening to the two slant grooves 7a and 7a, 7b and 7b

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Table 1

	Width of groove (mm)	Angle of groove *1 (°)	Depth of groove (mm)
Circumferential groove 3, 4	10	0	8
Groove portion 9a, 9b of slant groove	6 ~ 9	35	8
Groove portion 10a, 10b of slant groove	5	70	6 ~ 1
Additional groove 17	3	10	6
Rib-shaped land portion 8	Width of land portion: 16 mm, Height of land portion: 8 mm		
Pseude-land portion 11	Dimension of each side in slant surface 12: 55 mm × 50 mm × 7 mm,		
	Height of land portion: 8~1.6 mm, θ=130°, α=5°		
Corner part 15, 18 of land portion 13a, 13b	Length of chamfering: 15 mm		
Side edge part 19 of land portion 14a, 14b	Dimension of each side in slant surface of side edge part 19: 40 mm × 35 mm × 7 mm, Chamfered angle and height of land portion: the same as those in slant surface 12 of pseude-land portion 11		

(Note) * 1: Angle of groove is an angle measured with respect to equatorial plane of tire and an angle of groove extending from the bottom up as groove extends from equator side of tire toward end side of tread when viewing tread pattern shown in Fig. 1.

• Example 2

[0077] A tire of Example 2 is substantially the same as in Example 1 except that it has a tread pattern shown in Fig. 7 and dimensions of circumferential grooves 3, 4, slant grooves 7a, 7b, pseudo-land portion 11 and the like as shown in Table 2.

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• Example 4

[0079] A tire of Example 4 is substantially the same as in Example 1 except that it has a tread pattern shown in Fig. 11 and dimensions of circumferential grooves 3, 4, slant grooves 7a, 7b, pseudo-land portion 11 and the like as shown in Table 4.

Table 4

	Width of groove (mm)	Angle of groove *1 (°)	Depth of groove (mm)
Circumferential groove 3, 4	8	0	8
Slant groove 7a, 7b	9 ~ 6 ~ 5	20 ~ 40 ~ 85	8
Lateral sub groove 29	5	85	6 ~ 1
Conducting groove 31	5 ~ 1	-15 ~ 15	4
Sipe 30	0.7	-20	4
Sipe 33	0.7	-45	4
Rib-shaped land portion 8	Width of land portion: 16 mm, Height of land portion: 8 mm		
Pseude-land portion 11	Dimension of each side in slant surface 12: 45 mm × 40 mm × 6 mm, Height of land portion: 8~4 mm, θ = 135°, α = 8°		
Corner part 15 of land portion 16a, 16b	Length of chamfering: 20 mm		

(Note) *1: Angle of groove is an angle measured with respect to equatorial plane of tire and a positive (+) value thereof means an angle of groove extending from bottom to top as groove extends from equator side of tire toward end side of tread and a negative (-) value thereof means an angle of groove extending from top to bottom to the contrary shown in Fig. 11.

• Example 5

[0080] A tire of Example 5 is substantially the same as in Example 1 except that it has a tread pattern shown in Fig. 12 and dimensions of circumferential grooves 3, 4, slant grooves 7a, 7b, pseudo-land portion 11 and the like as shown in Table 5.

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water depth of 5 mm and increasing a speed stepwise to measure a speed generating a hydroplaning phenomenon.

[0085] The drainage property during the cornering is evaluated by running on a wet cornering road surface having a water depth of 5 mm and a radius of 80 m and increasing a speed stepwise to measure a speed generating a hydroplaning phenomenon.

[0086] The steering stability on the dry road surface is evaluated by a test driver's feeling when the vehicle is run on a circuit course of a dry road surface state by various sport-running modes.

[0087] The pattern noise is evaluated by a test driver's feeling on an indoor sound when the vehicle is run on a smooth road surface and then run by inertia from 100 km/h.

[0088] The evaluation results are shown in Table 7. Moreover, each numerical value in Table 7 is represented by an index on the basis that Conventional Example is 100, in which the larger the numerical value, the better the drainage properties during the straight running and the cornering, the steering stability on the dry road surface and the pattern noise.

Table 7

	Conventional Example	Example 1	Example 2	Example 3	Example 4	Example 5
Drainage property on wet road surface *1	100	120	125	120	120	120
Drainage property on wet road surface *2	100	115	120	115	115	120
Steering stability on dry road surface	100	110	105	110	110	105
Pattern noise	100	105	100	110	110	110

*1 : straight running,
*2 : cornering

[0089] As seen from the results of Table 7, all tires of Examples 1-5 are excellent in the drainage property on the wet road surface and the steering stability on the dry road surface as compared with the tire of Conventional Example, and are equal to or more than a level of the pattern noise in the tire of Conventional Example.

INDUSTRIAL APPLICABILITY

[0090] According to the invention, it is possible to provide pneumatic tires, particularly high-performance tires capable of effectively enhancing the drainage property without sacrificing the other tire properties such as pattern noise and the like.

Claims

1. A pneumatic tire comprising a tread portion provided with at least one circumferential groove extending along a circumferential direction of the tire and a plurality of slant grooves each opening to the circumferential groove and obliquely extending from such an opening position toward a ground contact end of a tread, characterized in that a pseudo-land portion(s) is formed in the circumferential groove so as to promote a smooth inflow of water flowing in the circumferential groove into the slant groove.

2. A pneumatic tire according to claim 1, wherein the pseudo-land portion is formed such that a cross sectional area thereof is gradually increased toward a given circumferential direction of the tire.

3. A pneumatic tire according to claim 1 or 2, wherein the pseudo-land portion is arranged in the circumferential groove so as to come an end part at a larger side of the cross sectional area of the pseudo-land portion close to the portion of the slant groove opened to the circumferential groove.

4. A pneumatic tire according to claim 1, 2 or 3, wherein the pseudo-land portion is arranged adjacent to a first groove

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the slant surface and a ground contact face of the rib-shaped land portion or a phantom plane arranged in parallel to such a ground contact face within a range of 120-150° viewing at a section in the widthwise direction of the tire.

24. A pneumatic tire according to any one of claims 1-23, wherein a corner part of a land portion defined by the arrangements of the circumferential groove, slant grooves and/or tread end at the side of the equatorial plane of the tire is formed at an acute angle and arranged at a position entering in the ground contact region on the heels of the pseudo-land portion.

25. A pneumatic tire according to claim 24, wherein the corner part is arranged on the same circumference of the tire as an intersecting point between a section of the pseudo-land portion having a maximum sectional area and the oblique side of the slant surface or on an extension line of the oblique side.

26. A pneumatic tire according to claim 24 or 25, wherein the corner part is subjected to a chamfering.

27. A pneumatic tire according to claim 26, wherein the corner part is subjected to a chamfering forming a smoothly curved shape.

28. A pneumatic tire according to any one of claims 24-27, wherein the corner part is connected with the pseudo-land portion.

29. A pneumatic tire according to any one of claims 1-28, wherein the slant groove opening to the circumferential groove is arranged so as to separate away from the circumferential groove toward a given circumferential direction of the tire.

30. A pneumatic tire according to any one of claims 1-29, wherein all of the slant grooves each opening to each of the pair of circumferential grooves and extending toward the respective ground contact end of the tread are arranged in a direction of successively entering in the ground contact face from the side of the circumferential groove toward the side of the ground contact end to thereby form a directional pattern in the tread portion.

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FIG. 2a

I - I section

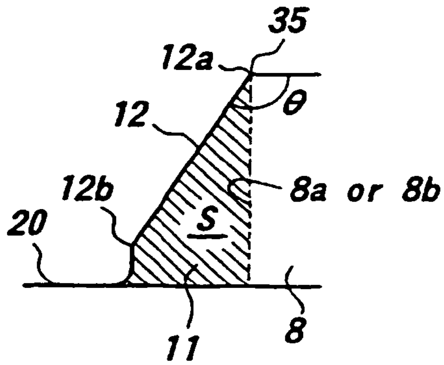

FIG. 2b

II - II section

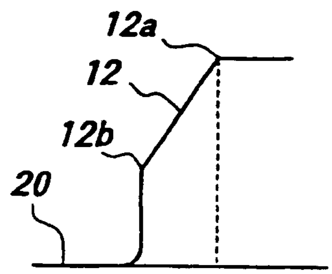

FIG. 2c

III - III section

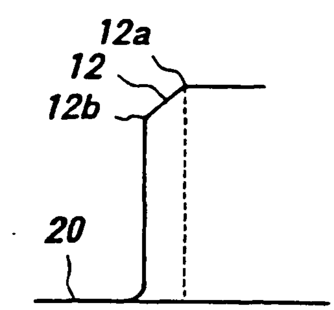

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FIG. 4a
I - I section

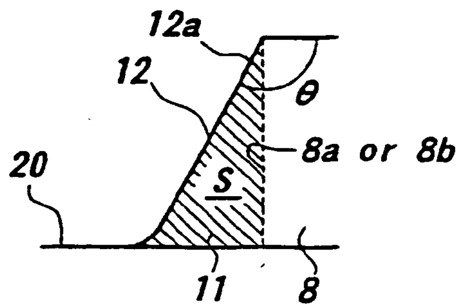

FIG. 4b
II - II section

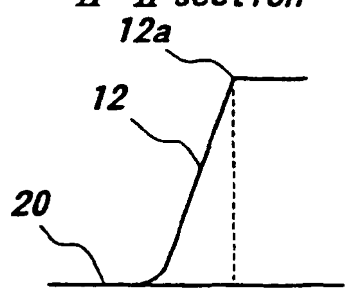

FIG. 4c
III - III section

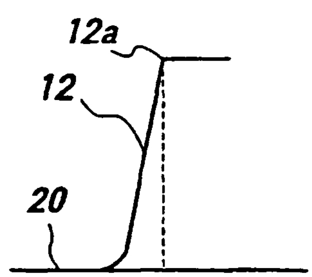

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FIG. 6a

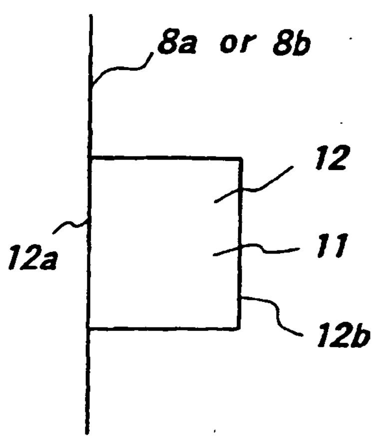

FIG. 6b

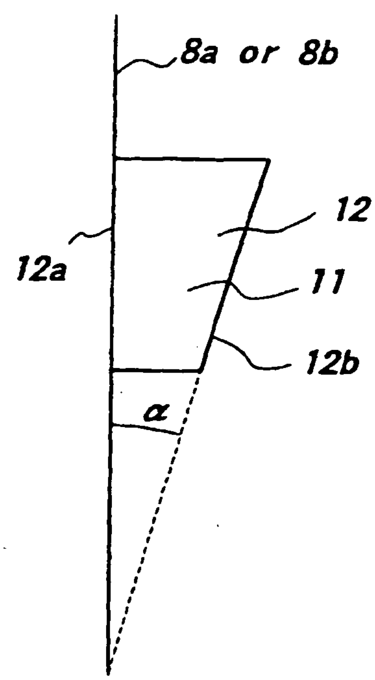

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FIG. 8

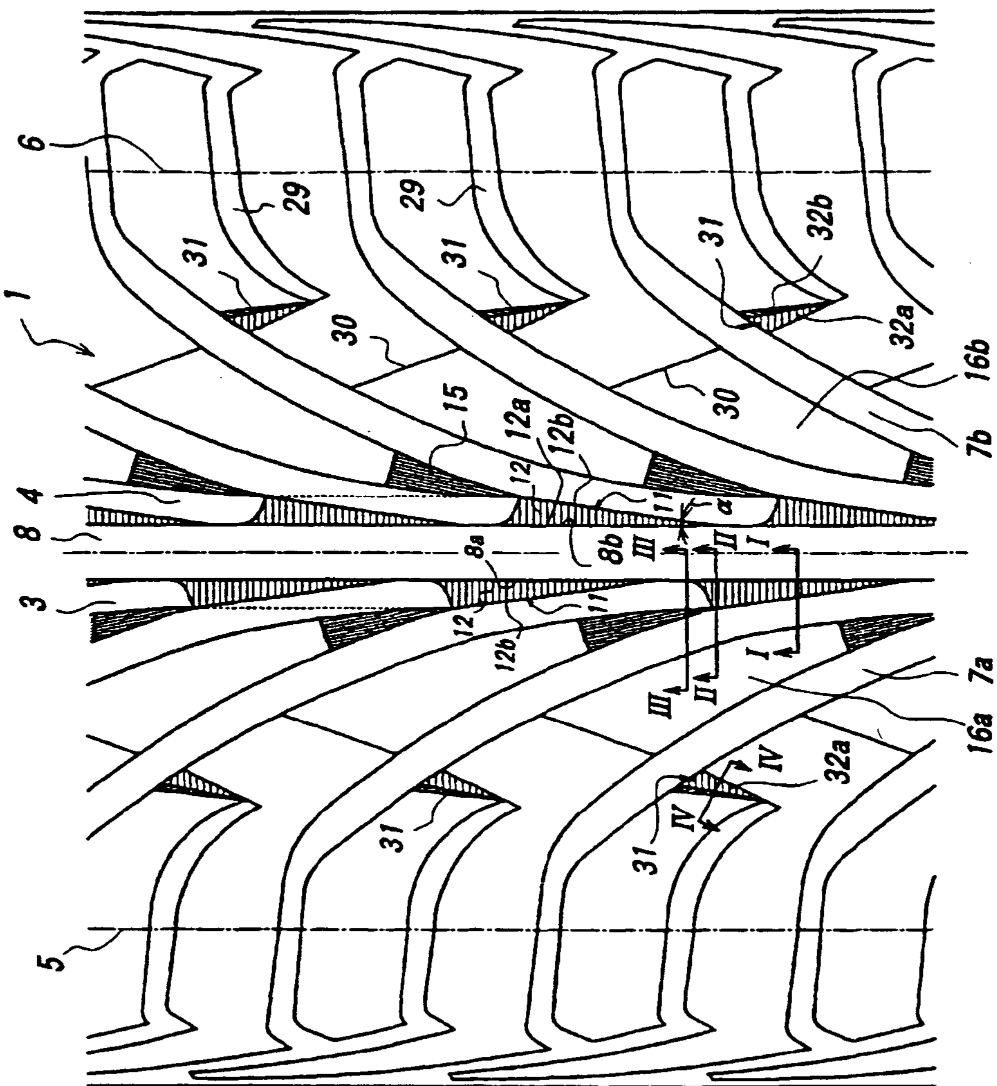

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FIG. 11

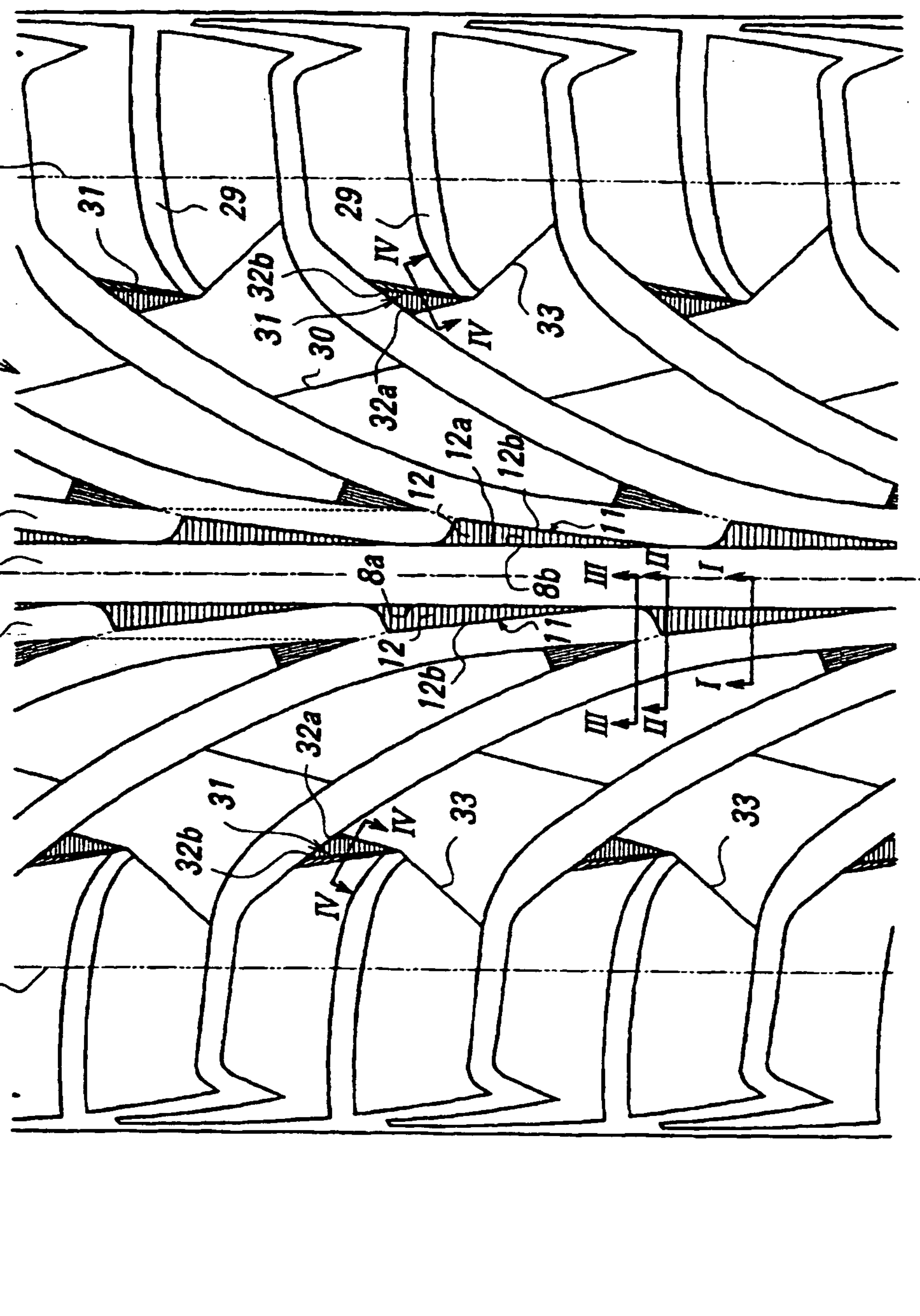

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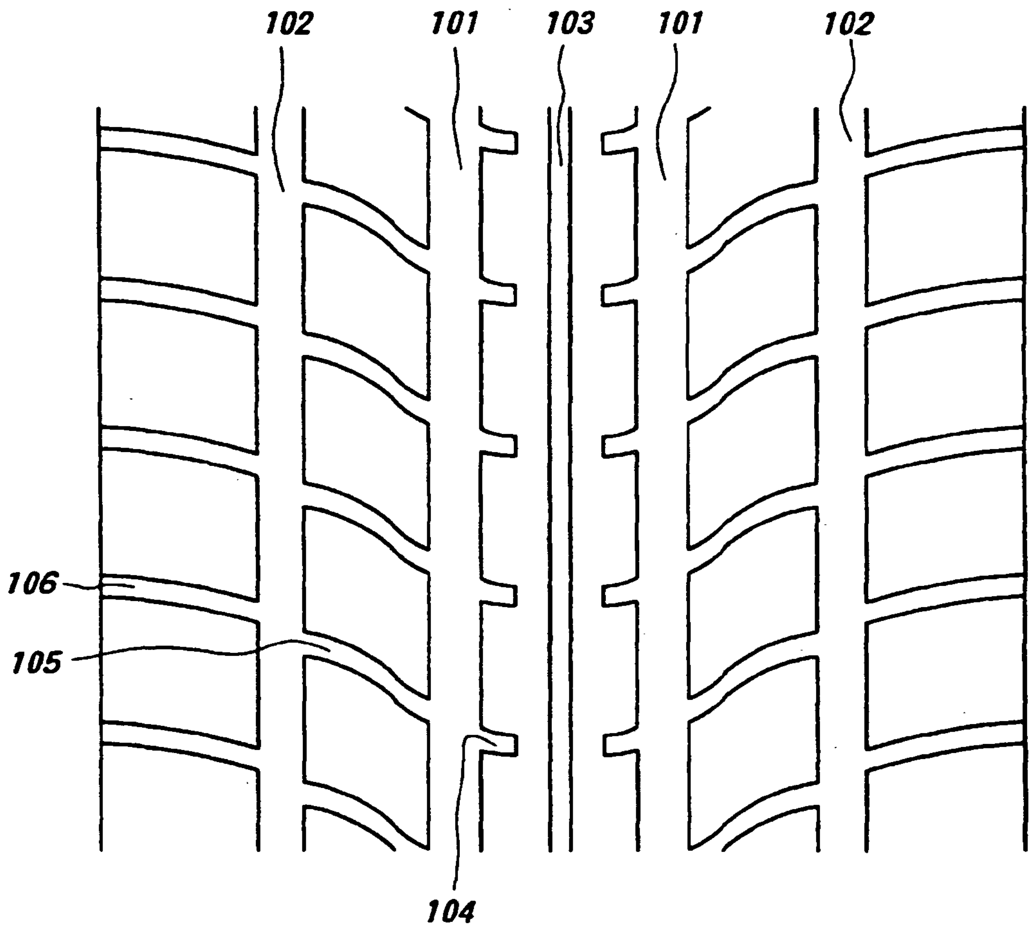
FIG. 13

PRIOR ART



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